Washington Avenue Bridge
Delaware, Lackawanna & Western Railroad
Scranton
Lackawanna County
Pennsylvania

HAER No. PA-132H

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

Historic American Engineering Record
National Park Service
Department of the Interior
Washington, D.C. 20013-7127

HAER
PA.
35-SCRAN.
4-H-

HISTORIC AMERICAN ENGINEERING RECORD

Delaware, Lackawanna & Western Railroad: Scranton Yards
Washington Avenue Bridge

HAER NO. PA-132H

LOCATION: Over Washington Avenue at Railroad Alley, Scranton, Lackawanna County, Pennsylvania.

UTM: 18/44433/458386
QUAD: Scranton

DATE OF CONSTRUCTION: 1906-08

ENGINEER/ ARCHITECT: Lincoln Bush, chief engineer

CONTRACTOR: McClintic-Marshall Construction Company

PRESENT OWNER: City of Scranton (South Span)
United States Department of the Interior, National Park Service (North Span)

PRESENT USE: Not in use.

SIGNIFICANCE: The Washington Avenue Bridge is typical of the plate girder and concrete railroad bridges built by the D,L & W after the turn of the century. The bridge carried passenger and freight traffic between the low-lying central Scranton yards and higher grades to the east.

HISTORIANS: Kathryn Steen and Amy Slaton
Delaware, Lackawanna & Western Railroad: Scranton Yards Recording Project, 1989

INTRODUCTION

Washington Avenue in Scranton, Pennsylvania bisected the railroad yards of the Delaware, Lackawanna & Western. On the west side, yards that had served the railroad since the 1850s covered low, uneven ground. To the east, tracks toward Hoboken rose at a steady grade out of town. A railroad bridge had crossed Washington Avenue just south of Lackawanna Avenue since around 1860, carrying trains into and out of the yards.[1] Shortly after 1900, the D,L & W began planning extensive new locomotive erecting shops and a power house east of Washington Avenue. The need for connections to this new portion of the yards, and increasing freight and passenger traffic on the Scranton division prompted the construction of a new bridge at this location between 1906 and 1908. The Washington Avenue Bridge, which is actually separate passenger and freight bridges placed next to each other, carried mainline tracks.

SUPERSTRUCTURE

Both parts of the Washington Avenue Bridge are deck plate girders, manufactured by the McClintic-Marshall Construction Company of Pottstown, Pennsylvania and erected by the D,L & W's own forces.[2] Plate girder bridges came into wide use in the late nineteenth century as steel processes developed. The basic openhearth furnace and improved rolling techniques allowed steel girders to be mass produced economically. The simplicity of the design, manufacture and maintenance made the plate girder a bridge material of choice for railroads. Plate girders could be used over spans of 20 to 100 feet.[3] To strengthen the girders, particularly in areas of more strain, the webs of the girders are reinforced by vertical "stiffeners" located near the ends of the girders and at intervals along the girder.[4] In the case of the Washington Avenue Bridge, most girders were riveted in the McClintic-Marshall shops and ready for final assembly upon arrival at the site.[5]

The bridge that carried passenger tracks over Washington Avenue lies north of the bridge that carried freight tracks. The passenger bridge is a four-track, eight-girder deck plate girder bridge. Each of the tracks on the deck is supported primarily by two girders. The girders are braced laterally in pairs. Each pair of girders is free to accommodate loads from its respective tracks.[6] The lateral bracing consists of a Warren trussing arrangement of horizontal supports at the upper and lower flanges of the girder. The horizontal lateral supports are periodically supplemented with vertical cross braces. Lateral bracing was necessary to make the bridge rigid enough to withstand the horizontal forces caused primarily by the acceleration and braking of locomotives.[7]

The freight track bridge carries five tracks and consists of ten girders. The lateral bracing is identical to the passenger bridge bracing. Both bridges rest on "shoes" at either end of the girders that transfer the load from the steel girders to the concrete abutments below. The movable shoes allow the metal in the bridge to expand and contract with changes in temperature without buckling.[8] In addition to the concrete abutments, the freight bridge has a four-column steel pier near each end to help support the girders.

The flooring system for both bridges is the same--a layer of I-beam stringers and reinforced concrete. Solid decks like that of the Washington Avenue Bridge, as opposed to open decks in which the ties are laid directly on the supporting girders, prevent debris from dropping below the bridge. More importantly, the solid floor prevents the rails from shifting. This solidity provides a smoother ride and makes maintenance easier.[9] The road bed was waterproofed at the time of construction with a commercial mix of wax and asphalt.[10]

SUBSTRUCTURE

The span of the Washington Avenue Bridge rests about 27 feet above street level on the passenger-track side, and about 19 feet above the street on the freight-track side. All the girders rest on concrete abutments, which may conceal masonry portions of the 1860 bridge on this site. (1918 records show that some masonry remains, but do not specify where.[11]) The bridge, including the road bed, contains 1,759 cubic yards of concrete.[12] The extra steel piers that support both ends of the freight-track portion of the bridge rest on individual 5-foot-deep concrete footings. These footings may have been partially visible when built, but they are now below pavement level.[13] The concrete abutments are of the "breast" type, comprised of the breast itself, which directly supports the bridge's superstructure and acts as a retaining wall for adjoining infill, and the "backwall," a gently sloped wall behind the breast that prevents retained material from encroaching on the bridge seat, or shelf.[14]

The "wings" of concrete bridge abutments are the portions that extend from either side of the breast. In free-standing overpasses, abutment wings usually extend at an angle away from the street, but the wings of the Washington Avenue Bridge are flush with the face of the breast. This arrangement probably derived from the fact that the bridge was built in the context of existing retaining walls that determined its shape; it is part of the long incline the D, L & W constructed over many years to carry trains between the low-lying yards and higher grades to the east. On their north ends, the bridge's east and west abutment wings meet the "China Wall," the high concrete retaining wall that runs along the north edge of the D,L & W's Scranton property. (This wall existed in the nineteenth century, but was improved in 1907.[15] It runs uninterrupted except for where it allows street traffic to pass under bridges at Washington and Cedar Avenues.) On its south end, the Washington

Avenue Bridge's west abutment wing meets a low masonry wall that runs parallel to the tracks above and may remain from 1860. The south-east abutment wing of the bridge meets a concrete retaining wall built in 1908 that rises as it goes east from Washington Avenue. This wall ends in two elevated concrete coal hoppers that stood inside the now-destroyed D,L & W power house.[16]

The concrete of the Washington Avenue Bridge is now somewhat deteriorated, but it can be assumed that this is in part due to the limited maintenance to the structure provided since the D,L & W dissolved in the 1960s. The railroad was known for its work with concrete, starting in 1902 when William K. McFarlin, the first chief engineer hired by President Truesdale (elected 1898), supervised the construction of concrete bridges, abutments and retaining walls for the elimination of grade crossings at Newark, New Jersey. In 1903, the D,L & W built a 40-foot concrete arch to replace a masonry structure at Bridgeville, New Jersey, and shortly thereafter used concrete in the foundations, floors and subways of their Keyser Valley and Kingsland shops. The railroad's first use of reinforced concrete was in their coal trestle at Hoboken, New Jersey in 1906. From 1908 to 1911, reinforced concrete was used extensively in the viaducts, culverts and bridges of the D,L & W's New Jersey cut-off. By 1912, the railroad was using concrete for everything from signal towers to fence posts, and had gained the nickname, "the reinforced concrete railroad."[17]

The use of concrete for industrial purposes in the U.S. had been steadily expanding since scientific research on the material began in earnest in the 1870s.[18] The D,L & W's large scale adoption of concrete after the turn of the century was no doubt a result of President Truesdale's vast modernization agenda. One architecture critic explained in 1913 that the D,L & W used concrete for its structures because brick and building stone were not always available along the lines of the railroad, and were expensive to transport. The writer blithely added that the use of brick and stone also "require the services of workmen who...must be brought from a distance, maintained and paid a rate of wage based on supposed, but not always realized efficiency."[19] Though the D,L & W may have wanted to save labor costs, this explanation of their use of concrete does not suffice: chief engineer Lincoln Bush (1903-1909) used reinforced concrete in his innovative "umbrella" train sheds, which were a radical departure from earlier kinds of sheds, not an inexpensive substitute. Further, the D,L & W's elaborate researches on concrete point as much to an interest in flexible and reliable materials as to cheap ones.

In laboratories at their Scranton yards, the D,L & W tested concrete for fineness and setting time, and subjected samples to "autoclave tests" for tensile strength (more rigorous than the conventional "boiling test"), and "digestion tests" in steam and hydrochloric acid. The company developed specifications that differed from those of the American Society of Civil Engineers, the American Institute of Architects and the Engineer Department of the U.S. Army.[20] The D,L & W also maintained rigorous inspection policies. All purchased cement was carefully inspected at the mill, and when materials were sent to the D,L & W, shippers were required to "furnish the [D,L & W's] chemist and engineer-of-test with analyses and physical tests showing results obtained upon the bin from which shipments are made."[21] This testing was apparently worthwhile because, though early concrete structures like the 1902 New Jersey retaining walls required repair by 1912, many other concrete structures of the D,L & W, including the massive Tuckhannock Viaduct (built in 1915 with 150,000 cubic yards of concrete) are still in use.[22]

NOTES

1.Interstate Commerce Commission, "Inventory Schedule of Structures," Valuation Section 21, Account No. 6, (December 10, 1919), 76.

2.McClintic-Marshall Construction Company, "Erection Plan Bridge #61 over Washington Avenue," June 16, 1906, owned by Delaware, Lackawanna and Western Railroad, Steamtown National Historic Site, Scranton, Pennsylvania.

3.J.A.L. Waddell, <u>Bridge Engineering</u>, Vol. I, first edition (New York: John Wiley & Sons, Inc., 1925), 46, 47, 408; and <u>Railway Engineering and Maintenance Cyclopedia</u>, third edition (New York: Simmons-Boardman Publishing Co., 1929), 29, 507; and Charles Lee Crandall and Fred Asa Barnes, <u>Railroad Construction</u> (New York: McGraw Hill Book Co., 1913), 239.

4.F.C. Kunz, <u>Design of Steel Bridges</u> first edition, (New York: McGraw-Hill Book Co., Inc., 1915), 157.

5.McClintic-Marshall, "Erection Plans," (plan).

6.Kunz, 145.

7.William Guy Williams, <u>I-Beam and Girder Plates</u> (Scranton, Pa.: International Textbook Co., 1947), 4.

8.Waddell, 211.

9.<u>Railway Engineering and Maintenance Cyclopedia</u>, 532-534; Williams, 2,5.

10.Interstate Commerce Commission, "Inventory Schedule of Structures," Valuation Section 21, Account No. 6, (December 10, 1919), 76.

11.I.C.C., "Inventory", 76.

12.I.C.C., "Inventory," 74.

13.McClintic-Marshall, "Erection Plan," (plan).

14.<u>Cyclopedia</u>, 447-448.

15.A. Berle Clemenson, Historic Resource Study: Steamtown National Historic Site (Denver, Colorado: National Park Service, Denver Service Center, 1988), 127.

16.I.C.C., "Inventory," 74; and Delaware, Lackawanna and Western Railroad Company, aerial photo, c. 1950, Steamtown National Historic Site, Scranton, Pennsylvania.

17.Railway Age, (October 14, 1922), 705; and "New Delaware, Lackawanna & Western Specifications for Portland Cement," Railway Age Gazette Vol. 54, No. 4.

18.Ada Louise Huxtable, "Concrete Technology: Historic Survey," Progressive Architecture, (October 1960), 147.

19."The Architectural Treatment of Concrete Surfaces," American Architecture Vol. CIV, No. 1978 (November 19, 1913), 193.

20."New Specifications."

21."New Specifications," 158.

22."Patching Concrete Retaining Walls by a Concrete-Spraying Machine," Engineering News Vol. 72, No. 15, 744.

BIBLIOGRAPHY

"The Architectural Treatment of Concrete Surfaces," American Architecture. Vol. CIV, No. 1978 (November 19, 1913), 193-197.

Clemenson, A. Berle. Historic Resource Study: Steamtown National Historic Site. Denver, Colorado: National Park Service, Denver Service Center, 1988.

Crandall, Charles Lee and Fred Asa Barnes. Railroad Construction. New York: McGraw-Hill Book Company, 1913.

Delaware, Lackawanna and Western Railroad Company. Aerial photograph, c. 1950. Steamtown National Historic Site, Scranton, Pennsylvania.

Huxtable, Ada Louise. "Concrete Technology: Historical Survey," Progressive Architecture. (October 1960), 144-149.

Interstate Commerce Commission. "Inventory Schedule of Structures." Valuation Section 21.

Kunz, F.C. Design of Steel Bridges. First edition. New York: McGraw-Hill Book Company, Inc., 1915.

McClintic-Marshall Construction Company. Erection Plan Bridge #61 over Washington Avenue. June 16, 1906. Plan for D, L & W bridge. Steamtown National Historic Site, Scranton, Pennsylvania.

"New Delaware, Lackawanna & Western Specifications for Portland Cement," Railway Age Gazette, Vol. 54, No. 4, 158-9ff.

"Patching Concrete Retaining Walls by a Concrete-Spraying Machine," Engineering News. Vol. 72, No. 15, 744.

Railway Age. (November 14, 1922).

Railway Engineering and Maintenance Cyclopedia. Third edition. New York: Simmons-Boardman Publishing Company, 1929.

Waddell, J.A.L. Bridge Engineering. Two volumes. First edition. New York: John Wiley and Sons, Inc., 1925.

Williams, William Guy. I-Beam and Girder Plates. Scranton, Pennsylvania: International Textbook Company, 1947.